

- 1    1. A photosensing organic field effect transistor (POFET), comprising:
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- 3                 a substrate insulating layer, the insulating layer having a high relative  
4                 dielectric constant and a first side and a second side;
- 5
- 6                 a gate electrode, the gate electrode being an electrical conductor, the gate  
7                 electrode being positioned adjacent to the first side of the insulating layer;
- 8
- 9                 a semiconducting polymer layer, the semiconducting polymer layer being  
10          responsive to incident light, the semiconducting polymer layer having a  
11          first side, a second side, a first end and a second end, the second side of  
12          the semiconductor layer being adjacent the second side of the insulating  
13          layer;
- 14
- 15          a source electrode, the source electrode being an electrical conductor, the  
16          source electrode being in electrical contact with the first end of the  
17          semiconductor layer; and
- 18
- 19          a drain electrode, the drain electrode being an electrical conductor, the  
20          drain being in electrical contact with the second end of the semiconducting  
21          polymer layer.
- 22
- 23    2. A POFET, comprising:
- 24
- 25                 a substrate insulating layer, the insulating layer having a high relative  
26                 dielectric constant and a first side, a second side, a first end and a second  
27                 end;
- 28
- 29                 a gate electrode, the gate electrode being an electrical conductor, the gate  
30                 electrode being positioned adjacent to the first side of the insulating layer;

1  
2       a source electrode, the source electrode being an electrical conductor, the  
3       source electrode being in electrical contact with the first end of the second  
4       side of the insulating layer;

5  
6       a drain electrode, the drain electrode being an electrical conductor, the  
7       drain electrode being in electrical contact with the second end of the  
8       second side of the insulating layer; and

9  
10      a semiconducting polymer layer, the semiconducting polymer layer being  
11      responsive to incident light, the semiconducting polymer layer being in  
12      electrical contact with the second side of the insulating layer and the  
13      source electrode and the drain electrode.

14  
15     3. The POFET of claim 1, wherein the semiconducting polymer layer further  
16     comprises a photoconducting polymer having a field effect mobility of  $10^{-2}$   
17     cm<sup>2</sup>/V-sec or greater.

18  
19     4. The POFET of claim 1, wherein the insulating layer has a dielectric constant of  
20     3.0 or greater.

21  
22     5. The POFET of claim 1, wherein the insulating layer is further comprised of a  
23     polymeric material.

24  
25     6. The POFET of claim 5, wherein the polymeric media is polyvinyl alcohol.

26  
27     7. The POFET of claim 5, wherein the polymeric media is polymethyl methacrylate.

28  
29     8. The POFET of claim 1, wherein the insulating layer is further comprised of an  
30     inorganic material.

- 1 9. The POFET of claim 1, wherein the insulating layer is at least semi-transparent to  
2 optical radiation.
- 3 10. The POFET of claim 1, wherein the insulating layer is further comprised of SiO<sub>2</sub>.
- 4
- 5 11. The POFET of claim 1, wherein the gate electrode is partially transparent.
- 6
- 7 12. The POFET of claim 1, wherein the semiconducting polymer layer further  
8 comprises a polymer matrix including, in dilute quantities, one or more electron  
9 acceptors selected from the group consisting of buckminsterfullerene C<sub>60</sub> and  
10 derivatives thereof, viologen, dichloro-dicyano-benzoquinone, nanoparticles of  
11 titanium dioxide, nanoparticles of cadmium sulphide and the like, thereby  
12 enabling electron transfer from the polymer matrix upon photoexcitation in order  
13 to obtain a high photo-induced current between the drain and source electrodes.
- 14
- 15 13. The POFET of claim 1, wherein a drain current (and transistor ON state) is  
16 independently controllable by a voltage applied to the gate electrode and by the  
17 intensity of light incident upon the POFET.
- 18
- 19 14. The POFET of claim 1, wherein the semiconducting polymer layer further  
20 comprises a regioregular polyalkylthiophene with 98.5% head-to-tail regiospecific  
21 conformation.
- 22
- 23 15. The POFET of claim 14, wherein the regioregular polyalkylthiophene is Poly (3-  
24 octylthiophene).
- 25
- 26 16. The POFET of claim 14, wherein the regioregular polyalkylthiophene is Poly (3-  
27 hexylthiophene).
- 28
- 29 17. A method of fabricating a POFET, comprising the steps of:  
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coating a glass substrate with a semi-transparent gate electrode;  
depositing upon the gate electrode an electrically insulating layer having a first side and a second side, the first side adjacent to the gate electrode; forming on the second side of the insulating layer a semiconducting polymer layer comprised of a regioregular polyalkylthiophene responsive to incident light and having a 98.5% head-to-tail regiospecific conformation; and  
forming on the semiconducting polymer layer electrically conducting source and drain electrodes.

18. The method of claim 17, wherein the insulating substrate is comprised of a polymeric media.
19. The method of claim 17, wherein the insulating substrate is partially transparent.
20. The method of claim 17, wherein the semiconducting polymer layer further comprises a polymer matrix including, in dilute quantities, one or more electron acceptors selected from the group consisting of buckminsterfullerene C<sub>60</sub> and derivatives thereof, viologen, dichloro-dicyano-benzoquinone, nanoparticles of titanium dioxide, nanoparticles of cadmium sulphide and the like, thereby enabling electron transfer from the polymer matrix upon photoexcitation in order to obtain a high photo-induced current between the drain and source electrodes.
21. The method of claim 17, wherein the regioregular polyalkylthiophene is Poly (3-octylthiophene).

- 1       22. The method of claim 17, wherein the regioregular polyalkylthiophene is Poly (3-  
2                 hexylthiophene)
- 3
- 4       23. The POFET of claim 1, wherein a POFET saturation current gain of 100 or higher  
5                 may be achieved.
- 6
- 7       24. A method of using a POFET as a logical element, comprising the step of:  
8                 activating a transistor ON state by controlling gate bias or the intensity of  
9                 incident light.
- 10
- 11      25. A method of using a POFET as a logical element, comprising the step of:  
12                 activating a transistor ON state by controlling gate bias and the intensity of  
13                 incident light.
- 14
- 15      26. A method of using a POFET as a backbone of a position sensitive detector,  
16                 comprising the steps of:  
17  
18                 positioning one or more photosensing organic FETs in a beam of light  
19                 incident from an object to be imaged; and  
20  
21                 monitoring the variation of drain current(s) from the one or more  
22                 photosensing organic FETs, wherein the drain current(s) vary with the  
23                 spatial position of the incident light beam.
- 24
- 25      27. A method of controlling the electrical properties of a POFET, comprising the step  
26                 of:  
27                 varying the intensity of light incident upon the photosensing organic FET,  
28                 thereby varying the carrier concentration in the channel region and the  
29                 drain-source current.